

# Systems modelling of the UK Industrial Strategy: The Contribution of Regional Higher Education Institutions to Wealth Creation

Extended Abstract

**Suggested: Theme: 8.**..Building an enterprising state

**Keywords:** innovation ecosystem; UK Industrial Strategy; policy modelling; system dynamics

## Abstract

A systems modelling approach is advocated to explore the structure of innovation in partnerships between HEIs and regional businesses, with government providing co-funding. The complexity and interdependence of innovation ecosystems implies that many components must be in place for the self-reinforcing mechanisms to work sustainably. The policy proposed by IPPR to extend funding of 'Catapult' centres in the UK to form regional Applied Research Innovation Centres is considered in the context of an overall UK Industrial Strategy.

## State of the art

The UK Industrial Strategy comprises developing strategic partnerships with industry, developing skills that businesses need, supporting emerging technologies, improving access to finance and publishing government contracts (BIS, 2013). In this paper, we propose a qualitative systems model to assess two components of this strategy for key interactions that underlying a) strategic partnerships and b) skills development via the Technology Strategy Board's 'Catapult' technology and innovation centres (TSB, 2011). We also propose a development of this model that could assess the Institute of Public Policy Research's proposal for diverting funding to the Catapult centres to establish a new network of Applied Research and Innovation Centres.

A systems modelling approach is advocated to map and model the UK's Industrial Strategy that aims to achieve a rebalancing of the economy through regional economic development. Systems modelling implies diagrammatic mapping and, optionally, subsequent quantitative modelling of the causal linkages of economic development using the triple helix metaphor. This approach entails representing the system resources, flows that alter resource levels and the interconnecting information-feedback structure that allows the causal drivers, constraints and network of information linkages that together control the dynamic performance of innovation ecosystems. By descriptive mapping, the possible loci of high-leverage policy interventions to encourage enterprise and

innovation can be identified and communicated. However, a full description of how the system behaves as a result of policy interventions requires explicit quantified models and simulation modelling since, without this, the consequences of the interplay of positive and negative feedbacks can only be hypothesised.

The Institute of Public Policy Research has argued that that higher education is a vital strategic asset to rebuild and rebalance the UK economy (IPPR, 2013). IPPR recommends that funding should be directed away from inefficient R&D tax credits towards applied research and innovations centres located in the regions with a priority on areas of significant economic disadvantage.

UK Trade and Investment recognised the breadth of industrial capability in the UK, a strong business environment, with an honest and trustworthy approach, and good international connections. However, the UK is seen as weaker in innovation and technology (UKTI, 2011). Industrial conglomerates such as Rolls-Royce and BAE Systems call for greater investment in skills and research to maintain innovation and win large orders. For example, Rolls-Royce has collaborated with 13 universities with about 400 current PhD students on its latest Trent XWB engine used in the new Airbus A350 but still claims that skills are holding back the aerospace industry (Cooper, 2013).

However, only 25.1% of small and medium-sized enterprises (SMEs) in the UK had introduced a product or placement innovation, whereas 32.1% of French SMEs and 53.6% of German SMEs had produced these innovations (EC 2012).<sup>1</sup> Additionally, the UK scores poorly on the amount of funding that businesses devote to R&D at universities (Hughes and Mina 2012). Lying behind these figures is evidence of a weak perception among businesses of the value of universities as innovation partners. Of the innovation-active companies responding to the UK Innovation Survey, only 1.9 per cent described universities as highly important sources of information, leaving universities as the least popular option on a list of possible sources of information (BIS 2012).

## **Methodology**

It is widely recognised that “innovation is a broad and complex phenomenon involving many interactive processes” (OECD, 2010, p18). Academic research on innovation has challenged the

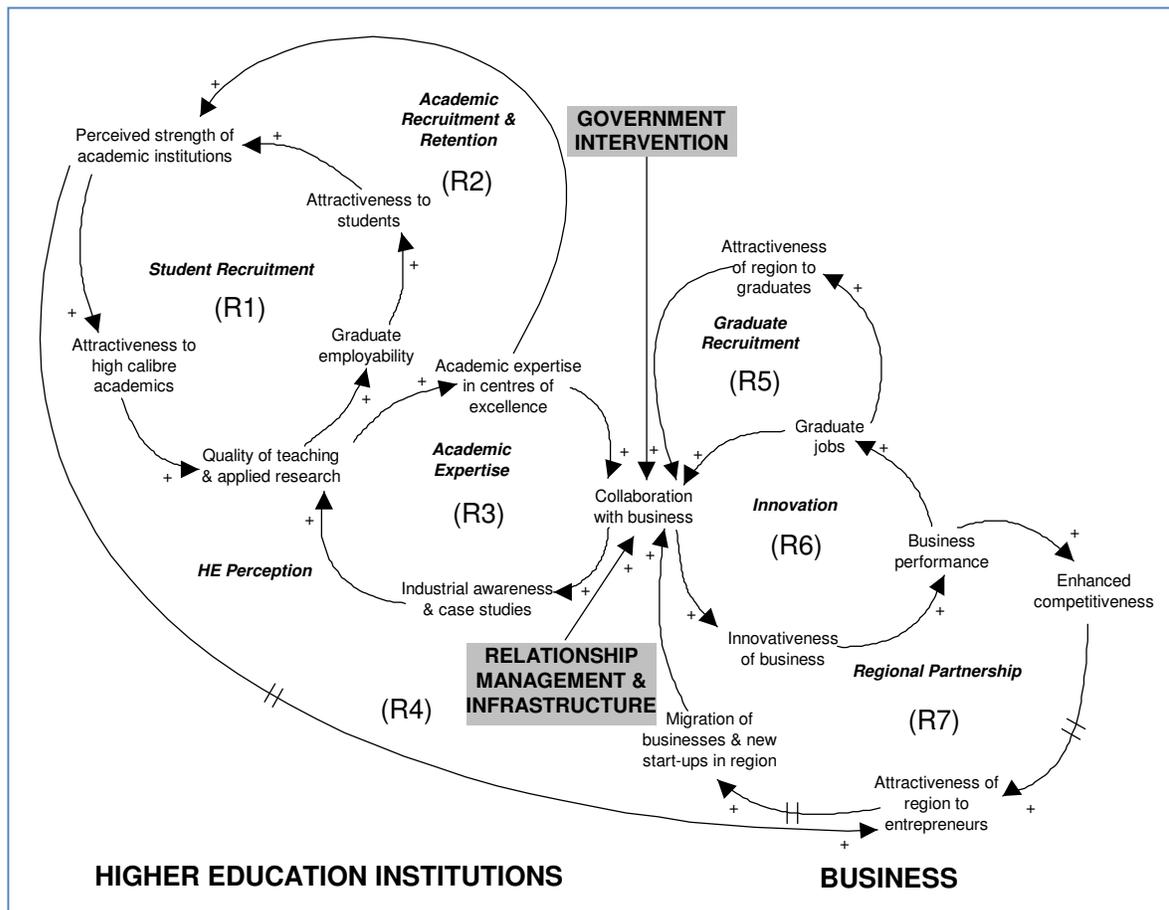
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<sup>1</sup> Placement innovation refers to new methods in placement, marketing or sales, such as franchising, distribution licences, new concepts for product presentation and so on.

traditional “linear” view of innovation for a considerable time and there is now a significant body of theoretical and empirical evidence which supports the iterative model of the relationship between science and innovation where “innovation draws on science, but also the demands of innovation force the creation of science” (CIHE, 2012; Kline and Rosenberg, 1986).

**Causal/influence diagrams of the innovation ecosystem**

A set of components driving growth in a wider higher education-industry innovation ecosystem can be proposed, and their causal linkages mapped out. Figure 1 is a simplified HE/industry ecosystem with a set of six interacting reinforcing feedback loops representing the interplay of the structural drivers of ecosystem dynamics.

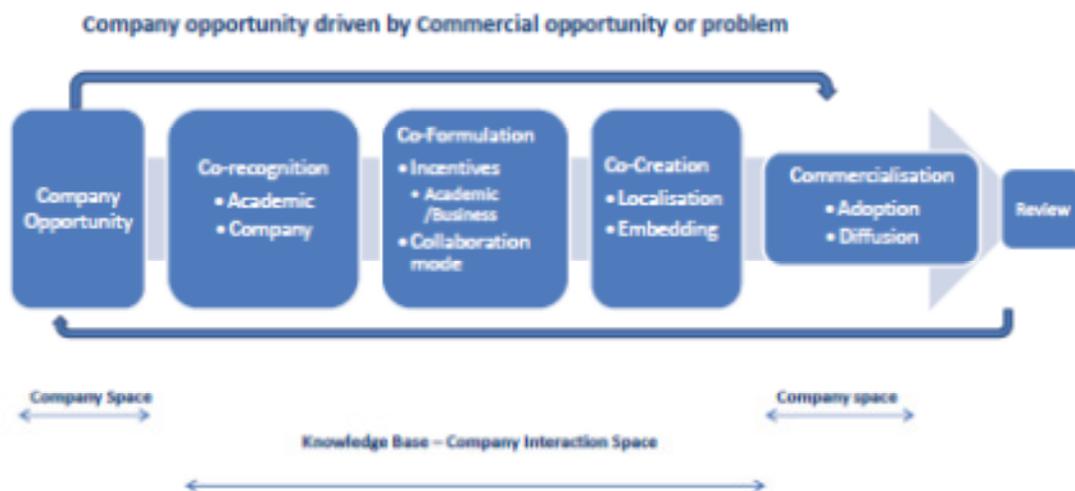


**Fig. 1. Reinforcing feedback loops in a regional innovation ecosystem (developed from Arthur and Moizer, 2000)**

**Table 1: Reinforcing loops and possible intervention policies**

Reinforcing Structure	Possible intervention policy lever
R1 – Student recruitment	Marketing, funding, entrance qualifications
R2 – Academic recruitment	Quality of life and applied research opportunities
R3 – Academic expertise	Investment in Centres of Expertise, investment in applied research
R4 – Perception of region for innovation	HEI marketing for 'business reachout'
R5 – Graduate recruitment	Knowledge transfer-based recruitment
R6 – Business Innovation	Investment in research/innovation projects
R7 – Regional partnerships	Infrastructure funding to encourage entrepreneurship

However, innovation models are invariably presented in a linear or 'laundry list' of factors as in the case of university-business knowledge transfer relationships (CIHE, 2012). In the CIHE report on Knowledge Transfer Partnerships, quantitative modelling of impacts was only carried out with multivariate regressions using ordered probit models that only posit correlations, not explicit causal relationships. For example, the generic process by which knowledge transfer takes place is illustrated by CIHE (2012) in the 5Cs diagram, as illustrated in Fig 2.



**Fig 2: 5Cs generic process model for knowledge transfer in Open Innovation (CIHE, 2012)**

## **Findings and interpretation**

From the causal diagram in Figure 1, policy interventions would appear critical at the key “Collaboration with business” variable. The policy levers identified are as follows but the scale of their importance needs to be quantified in further research.

1. Government intervention: this suggests that seed-funding funding of knowledge transfer programmes and other university-business partnerships is critical to get the system going but what degree of critical mass is required before the momentum becomes self-sustaining or does the system performance break down without continuing subsidies?
2. Relationship management and infrastructure. This implies that facilities and supporting administrative, reach-out and market development staff are available to facilitate ongoing interactions between HEIs and regional businesses. Other facilities might include incubation and business training in IPR and commercialisation. What level of supporting infrastructure investment is required?

Many of the United Kingdom’s universities were created in the 19th century to meet the needs of their local communities. They were established by local industrialists and civic leaders to enhance the economic, cultural and social life of their surrounding regions. Today, Higher Educational Institutions still play a tremendously important regional and civic role, acting as a hub for economic growth, direct employment, support for local businesses, provision of volunteers and related service and buildings and physical infrastructure that offers many cultural and social activities. However, funding cuts to other institutions present an opportunity to HEIs, which can act as anchors for their local economies and communities – filling the void that has been created by the withdrawal or shrinking of other key institutions. Universities and colleges will need to weave their ‘civic mission’ as a key part of the UK’s Industrial Strategy across their core functions of teaching (IPPR, 2013, p66).

The IPPR (2013) report suggested that Britain's industrial strategy can achieve regional economic rebalancing by ensuring that growth is distributed in a way that benefits all parts of the country. Therefore, a regional focus should be an integral part of a proposed Applied Research and Innovation Centre programme (ARIC), funded from changes to the R&D tax credits policy, which is deemed inefficient. ARICs are proposed to focus on promoting growth in lagging economic regions, which have generally weak economic growth but with both historic and existing strengths in particular fields, for example aerospace in the North West and engineering in the North East. The ARIC programme could help to provide an innovation platform for businesses in these regions.

## **Conclusions**

Models that incorporate factors of production should recognise the systemic and complex nature of the multiple drivers of the triple helix. Qualitative models often refer to the importance of co-ordination and may explicitly or implicitly refer to information feedbacks. Quantitative models often use multivariate regressions that do not represent causal influences. In a system dynamics approach, qualitative models can be used in 'system description' phase which can then lead to full policy analysis with quantitative models. Qualitative models can act as a prelude to analysis of the drivers, constraints and identification of high-leverage policies is a systemic overview as depicted in a systems-based diagram. However, the dynamic implications of policy interventions that may be implied within the system map cannot be inferred by observation and discussion, although this is the normal mode of policy making. Qualitative models serve as a powerful issue-framing and communication device for a more detailed assessment of the impacts of policy interventions. There is a tradeoff between greater data demands and the benefits of quantitative simulation modelling, both process and outcome.

## **Policy implications**

Implications from this work point to the need to review the structural location of the proposed IPPR policy to divert £1billion of R&D tax incentives to focus on Applied Research and Innovation Centres.

High leverage policy interventions can only be suggested by causal loop diagrams but these can inform debate at a high level but also lead to a richer and more 'operational' thinking by being explicit about causal (as opposed to correlative) interconnections of social and economic drivers and effects.

A model development project should be funded to quantify the above systems-based model which could be used to test the IPPR policy recommendations for extending the TSB Catapult centre funding of Applied Research and Innovation Centres by diverting existing government R&D tax credits.

### **Selected References**

Arthur DJW and Moizer JD (2000). Macro regional economic development from micro-level partnerships between the higher education and business sectors. Proceedings of the International System Dynamics Conference, Bergen.

BIS (2010). Community Innovation Survey 2009 (CIS) 7. London: Department of Business Innovation and Skills, December 2010. Referenced in: CIHE (2012).  
<http://www.bis.gov.uk/assets/biscore/science/docs/u/10-p107a-uk-innovation-survey-2009-science-and-innovation-analysis.pdf>

BIS (2013). Using Industrial Strategy to help the UK economy and business compete and grow. Department for Business Innovation and Skills, updated 18 April 2013.  
<https://www.gov.uk/government/policies/using-industrial-strategy-to-help-the-uk-economy-and-business-compete-and-grow/supporting-pages/supporting-emerging-technologies>

Cooper, K (2013). Your starter for 10: design an engine to make us proud. Sunday Times Business Section, p9, 16 June 2013.

CIHE (2012). Key Attributes for Successful Knowledge Transfer Partnerships. Report Commissioned by the Technology Strategy Board and the Research Councils. Philip Ternouth, Cathy Garner, Laurie Wood and Peter Forbes. Council for Industry and Higher Education (CIHE), August 2012.  
<http://www.ktponline.org.uk/assets/CIHE-KTP-Study-Report.pdf>  
[www.cihe.co.uk/wp-content/themes/cihe/document.php?file=1208KTP\\_TSB.pdf](http://www.cihe.co.uk/wp-content/themes/cihe/document.php?file=1208KTP_TSB.pdf)

European Commission [EC] (2012). Innovation Union Scoreboard 2011.  
[http://ec.europa.eu/enterprise/policies/innovation/files/ius-2011\\_en.pdf](http://ec.europa.eu/enterprise/policies/innovation/files/ius-2011_en.pdf)

Hughes A and Mina A (2012). *The UK R&D Landscape*, London: CIHE. [http://www.cihe.co.uk/wp-content/themes/cihe/document.php?file=PR\\_RDlandscape.pdf](http://www.cihe.co.uk/wp-content/themes/cihe/document.php?file=PR_RDlandscape.pdf)

IPPR (2013). A critical path: Securing the future of higher education in England. Institute for Public Policy Research Commission on the Future of Higher Education, June 2013.  
[http://www.ippr.org/images/media/files/publication/2013/06/critical-path-securing-future-higher-education\\_June2013\\_10847.pdf](http://www.ippr.org/images/media/files/publication/2013/06/critical-path-securing-future-higher-education_June2013_10847.pdf)

Kline SJ and Rosenberg N (1986). An overview of innovation. In: R. Landau and N. Rosenberg, eds. (1986). *The Positive Sum Strategy: Harnessing Technology for Economic Growth*. Washington, D.C.: National Academy Press, pp.275–305.

OECD (2010). Getting A Head Start on Tomorrow. Paris: OECD.

Technology Strategy Board [TSB] (2011) Technology and innovation centres: Closing the gap between concept and commercialisation, strategy and implementation plan, Swindon.  
<https://www.innovateuk.org/documents/1524978/2138994/Technology+and+innovation+centres+strategy+and+implementation+plan/>

UKTI (2011). Britain Open for Business. Growth through international trade and investment. UK Trade and Investment, May 2011.

